APPLICATION UNDER UNITED STATES PATENT LAWS

Invention: AIR CONDITIONER FOR A VEHICLE

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SPECIFICATION

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AIR CONDITIONER FOR A VEHICLE

FIELD OF THE INVENTION

The present invention relates to an air conditioner for a vehicle, which is used in a vehicle having, as a power source for driving the vehicle, an engine or both an engine and an electric motor.

BACKGROUND ART

In recent years, a hybrid car has been proposed in which an electric motor which electrically produces driving force is provided in addition to an engine which produces driving force by combusting fuel such as gasoline. In this hybrid car, even if the engine is stopped, the electric motor is driven by electric power supplied from a battery, which has been previously charged or which is charged by power generated by the engine during traveling, so as to drive the hybrid car.

On the other hand, even in an air conditioner provided in this type of hybrid car, it is necessary that a compressor be driven when air-conditioning the vehicle interior. For this reason, as disclosed in Japanese Patent Application Laid-Open (JP-A) No. 6-286459, the engine is started by operating a switch of an air conditioner when the engine is stopped, and a compressor is driven by the driving force of the engine.

As a result, a motor used only for driving a compressor of an air conditioner becomes unnecessary, and the air conditioner can be operated without using the driving force of an electric motor or the electric power of a battery to operate the electric motor.

However, in the above-described structure, it is necessary that the engine be started when operating the air conditioner. As a result, there exist drawbacks in that the driving force of the engine is used only for driving the compressor, which results in deterioration in fuel consumption, and the efficiency of utilization of power is also extremely low.

Accordingly, in view of the above-described circumstances, an object of the present invention is to provide an air conditioner for a vehicle, which allows air conditioning by efficiently utilizing the driving force of an engine or the driving force of an engine and an electric motor without providing driving means used only for driving a compressor.

DISCLOSURE OF THE INVENTION

The present invention is an air conditioner for a vehicle, which air conditions a vehicle interior by a refrigerating cycle formed to include a compressor and an evaporator, said air conditioner for a vehicle comprising a water cooling cycle which is formed by water refrigerant heat exchange means provided in the refrigerating cycle and cooling water which is supplied as a refrigerant, heat storage means for cooling in which one of water

cooled by said water-refrigerant heat exchange means and cooling heat obtained from water is stored, and heat dissipation means for cooling which cools air to be blown out into the vehicle interior by water supplied as a refrigerant from said heat storage means for cooling.

As a result, while the vehicle is running by the engine, the compressor is driven to allow cooling (air conditioning). At this time, water is cooled by the refrigerating cycle and is stored in the heat storage means for cooling. Subsequently, when a cooling operation is carried out while the engine is stopped or when the vehicle is being run by the driving of the electric motor, cooled water is supplied from the heat storage means for cooling to the heat dissipation means for cooling to allow cooling of air to be blown out into the vehicle interior.

Accordingly, it is possible to carry out a cooling operation for the vehicle interior without driving the compressor and it is not necessary that the engine be started to drive the compressor. For this reason, deterioration of fuel consumption can be prevented. Further, driving means such as a motor for driving the compressor while the engine is stopped becomes unnecessary.

Further, the present invention comprises a water heating cycle which is formed by heat storage means for heating in which one of water heated by an engine and heating heat obtained from water is stored, and heat dissipation means for heating, which heats air to be blown out into the vehicle interior by supplying, as

a refrigerant, one of cooling water for the engine and water heated by heat stored in said heat storage means for heating so as to allow heating of the vehicle interior.

As a result, cooling water heated by the engine at the time of being driven is stored in the heat storage means for heating. When a heating operation is carried out at the time of driving the engine, cooling water for the engine is used to heat air to be blown out into the vehicle interior. Further, when the heating operation for the vehicle interior is carried out in a state in which the engine has been stopped, the cooling water during driving of the engine is supplied from the heat storage means for heating to the heat dissipation means for heating so as to allow heating of the air to be blown out into the vehicle interior.

Accordingly, even when the engine is stopped, heating in the vehicle interior using the heat of the engine becomes possible without starting the engine. Even if heating using the heat of the engine is carried out, no deterioration of fuel consumption occurs.

By providing both the water cooling cycle and the water heating cycle, heating and cooling can be carried out according to a vehicle occupant's preference. Further, it is also possible to carry out heating for the vehicle interior while carrying out dehumidification, without operating the compressor.

The present invention comprises: heat storage means which can be used as both the heat storage means for cooling and also as the heat storage means for heating; first circulating

means which can circulate water which becomes a refrigerant between the engine and said heat dissipation means for heating; second circulating means which can circulate water which becomes a refrigerant between said water-refrigerant heat exchange means and said heat dissipation means for cooling; and circulating passage switching means which changes said heat storage means to said first circulating means and said second circulating means to allow circulation of the water by any one of said first circulating means and said second circulating means.

As a result, the first and second circulating means each allowing circulation of water used as a refrigerant are switched, and cool storage or heat storage is carried out by a single heat storage means. When the engine is stopped, water which becomes a refrigerant by the cool storage or the heat storage in the heat storage means is circulated to allow cooling or heating. Accordingly, reduction in the number of parts which are used for heating and cooling can be achieved.

The determination as to whether the heat storage means is used as a heat source for heating or a heat source for cooling may be made in accordance with the operating state of the air conditioner or environmental conditions such as the outside air temperature, the vehicle-interior temperature, and the like. For example, when the cooling operation is carried out by the air conditioner, there is a high possibility of the cooling operation being continuously carried out. For this reason, the second

circulating means may be switched to allow circulation of water so that the heat storage means is used as the heat source for cooling. Further, when the outside air temperature is low in the winter or the like, there is a high possibility the heating operation will be carried out, and therefore, the first circulating means may be used to allow the circulation of water, serving as a refrigerant, between the heat storage means and the first circulating means.

Meanwhile, not only the heat storage means, but the heat dissipation means for heating and the heat dissipation means for cooling may be used in common with each other. In this case, during heat storage, only the circulating means needs to be switched between heating and cooling, and at the time of heat dissipation (heating or cooling), water serving as a refrigerant only needs to be supplied from the heat storage means to the heat dissipation means. As a result, heating or cooling can be carried out in accordance with the heat stored in the heat storage means. Accordingly, the structures of the water cooling cycle and the water heating cycle can be simplified.

Further, the present invention is an air conditioner for a vehicle, which is provided in a vehicle equipped with an engine and an electric motor and which air conditions a vehicle interior by a refrigerating cycle formed to include a compressor and an evaporator, said air conditioner for a vehicle comprising: driving shafts provided respectively in the engine and in the electric motor; an output shaft connected to said driving shafts of the

engine and the electric motor and rotated synchronously with a driving source which is one of the engine and the electric motor; driving force transmitting means which connects a driving shaft of one of the engine and the electric motor and a driving shaft of the compressor so as to transmit a driving force of said output shaft to the compressor; and driving force switching means which switches a driving source of the driving force to be transmitted to the driving shaft of the compressor by said driving force transmitting means.

As a result, when the output shaft is driven by the electric motor, the driving source of the compressor is switched by the driving force switching means to separate the driving shaft of the engine and the driving shaft of the compressor from each other, and the compressor is driven by the driving force of the electric motor. As a result, no load for rotating the driving shaft of the engine is applied to the electric motor, and therefore, the compressor can be driven by the driving force of the electric motor. It is not necessary to provide driving means used only for driving the compressor and also not necessary to start the engine to drive the compressor. Accordingly, consumption of fuel caused by driving the engine can be restrained.

The present invention is characterized in that said driving force switching means is clutch means provided between the driving shafts of the engine and the electric motor and said output shaft. When the output shaft is driven by the electric

motor, the driving shaft of the engine and the output shaft are separated from each other by the driving force switching means. As a result, the application to the electric motor of a load for rotating the driving shaft of the engine can be prevented.

The present invention comprises: first driving force transmitting means, which is provided as said driving force transmitting means, for transmitting driving force from the driving shaft of the engine to the driving shaft of the compressor; second driving force transmitting means which transmits driving force from the driving shaft of the electric motor to the driving shaft of the compressor; and clutch means which is provided as said driving force switching means and separates one of said first driving force transmitting means and said second driving force transmitting means from the driving shaft of the compressor.

As a result, when the driving force switching means is provided at the side of the driving shaft of the compressor and the engine is driven, the driving force of the engine is transmitted by the first driving force transmitting means, and when the electric motor is driven, the driving force of the electric motor is transmitted by the second driving force transmitting means.

Accordingly, only a load for driving the compressor is applied to the driving force switching means, and as compared with the case in which the driving force switching means is provided in the output shaft, the capacity of the driving force switching means can be made extremely small. For example,

when a clutch is used as the driving force switching means, a small-size and low-cost clutch can be obtained.

Moreover, the present invention is an air conditioner for a vehicle, which is provided in a vehicle equipped with an engine and an electric motor and which air conditions a vehicle interior by a refrigerating cycle formed to include a compressor and an evaporator, said air conditioner for a vehicle comprising: driving shafts provided respectively in the engine and in the electric motor; an output shaft connected to said driving shafts of the engine and the electric motor and rotated synchronously with a driving source which is one of the engine and the electric motor; load reduction means for reducing the driving load of said output shaft which rotates integrally with the driving shaft of the engine when the electric motor is driven; and driving force transmitting means which connects said output shaft and the driving shaft of the compressor to transmit the driving force of said output shaft to the compressor.

According to the above-described structure, when the electric motor is driven, a load for rotating the driving shaft of the engine connected to the output shaft of the electric motor is reduced by the driving load reduction means.

Generally, when the driving shaft of the engine in a stopped state is rotated, air within a piston of the engine must be compressed, and therefore, a driving load is extremely high. Accordingly, in order to rotate the driving shaft of the engine, an

extremely large driving force is required. On the other hand, so long as the driving load reduction means operates so as to, for example, open a valve which allows air supply and exhaust for a cylinder of the engine or open a throttle valve which opens and closes a passage of air to be supplied into the cylinder of the engine, compression of air within the cylinder of the engine or increase in air-intake resistance can be prevented, thereby allowing reduction of a load for rotating the driving shaft.

As described above, so long as the load for rotating the output shaft when the engine is stopped is reduced by the driving load reduction means, the compressor can be driven by using the driving force of the electric motor. In this case, in the same manner as the aforementioned, it is not necessary to provide driving means used only for driving the compressor and it is also not necessary to start the engine to drive the compressor. For this reason, consumption of fuel caused by driving the engine can be restrained.

Still further, the present invention is an air conditioner for a hybrid car, which air conditions a vehicle interior by a refrigerating cycle formed to include a compressor and an evaporator, said air conditioner for a hybrid car comprising: an auxiliary-machine motor which drives a plurality of auxiliary machines provided in the hybrid car; third driving force transmitting means which can transmit the driving force of the engine and the driving force of said auxiliary-machine motor to

the plurality of auxiliary machines and also to the driving shaft of the compressor; driving force interrupting means which interrupts the driving shaft of the engine and said third driving force transmitting means; and control means which controls said driving force interrupting means and said auxiliary-machine motor in accordance with a state in which the engine is driven.

As a result, when the engine is driven, the driving force of the engine is transmitted by the third driving force transmitting means to auxiliary machines including the compressor. Further, when the engine has been stopped, the driving shaft of the engine and the third driving force transmitting means are separated from each other by the driving force interrupting means and the compressor is driven by the driving force of the auxiliary-machine motor.

Accordingly, when the engine is stopped, the compressor can be driven by the auxiliary-machine motor in the same way as in other auxiliary machines provided in the vehicle, and when the engine is being driven, the auxiliary machines including the compressor can be driven by the driving force of the engine.

Namely, as the electric motor, an electric motor provided as a driving source for a running operation may be used, or an electric motor provided as a driving source for driving various auxiliary machines including the compressor and the like may also be used. Further, in addition to the electric motor provided as the driving source for a running operation, an electric motor

serving as a driving source of auxiliary machines may also be provided.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic structural diagram of an air conditioner according to a first embodiment.

Fig. 2 is a schematic structural diagram which shows the arrangement of an engine and an electric motor of a hybrid car applied to the first embodiment.

Fig. 3 is a flow chart which shows an example of heat storage processing.

Fig. 4 is a flow chart which shows an example of heat dissipation processing.

Fig. 5 is a schematic structural diagram of a hybrid car and an air conditioner according to a second embodiment.

Fig. 6 is a schematic structural diagram of an air conditioner according to a third embodiment.

Fig. 7 is a schematic cross-sectional diagram of a principal portion, along an axial direction of a driving shaft of a compressor, of a double pulley clutch which is applied as an example of driving force switching means to the third embodiment.

Fig. 8 is a flow chart which shows an example of a driving-source switching operation according to the third embodiment.

Fig. 9 is a schematic structural diagram of a hybrid car and an air conditioner according to a fourth embodiment.

Fig. 10 is a schematic structural diagram of a hybrid car and an air conditioner according to a fifth embodiment.

Fig. 11A is a schematic structural diagram of an air conditioner applied to a sixth embodiment.

Fig. 11B is a schematic structural diagram which shows transmission of driving force based on Fig. 11A.

Fig. 11C is a schematic structural diagram which shows another example of transmission of driving force, which is different from that in Fig. 11B.

Fig. 12 is a flow chart which shows an example of a driving-source switching operation according to the sixth embodiment.

BEST MODES FOR CARRYING OUT THE INVENTION

An air conditioner for a vehicle according to the present invention will be hereinafter described in detail with reference to the attached drawings.

(First Embodiment)

Fig. 1 shows a schematic structure of an air conditioner for a vehicle (hereinafter referred to as “air conditioner 10”) applied to a first embodiment. Fig. 2 schematically shows a portion of a hybrid car 12, which is an example of a vehicle equipped with the air conditioner 10.

As shown in Fig. 2, the hybrid car 12 equipped with the air conditioner 10 includes, as a power source for traveling, an electric motor 16 in addition to an engine 14. The electric motor 16 and the engine 14 are each connected to an output shaft 18 directly or indirectly. In Fig. 2, as an example, the output shaft 18 is connected to the electric motor 16 so that a driving shaft of the electric motor 16 becomes the output shaft 18, and a driving shaft 14A of the engine 14 is connected to the output shaft 18. As a result, the output shaft 18 is driven to rotate by the engine 14 or the electric motor 16. The electric motor 16 is driven by electric power supplied from, for example, a previously charged battery (not shown) mounted before traveling.

The hybrid car 12 is provided with the compressor 20 disposed adjacent to the engine 14. A pulley 22 is mounted to a driving shaft 20A of the compressor 20 and an endless V belt 26 is entrained between the pulley 22 and a pulley 24 mounted to the driving shaft 14A of the engine 14. When the engine 14 is started, driving force is transmitted via the V belt 26 to the compressor 20.

As shown in Fig. 1, in the air conditioner 10, a refrigerating cycle is formed by a circulating passage of a refrigerant including the compressor 20, a capacitor 28, and an evaporator 30. A refrigerant liquefied by being compressed by the compressor 20 is supplied to the evaporator 30, and when the

refrigerant is decompressed to be vaporized, air to be blown out into a vehicle interior is cooled.

The pressure of the refrigerant supplied to the evaporator 30 is adjusted by controlling the capacity of the compressor 20. Further, water in the cooled air is applied to the evaporator 30 by dew condensation, and in the air conditioner 10, not only at the time of a cooling operation, but also at the time of a heating operation, a dehumidifying operation can be effected by operating the compressor 20 at a predetermined capacity.

The evaporator 30 is provided within an air-conditioning duct 32. The air-conditioning duct 32 is provided with blower fans 34. Outside air or air within a vehicle interior is sucked into the air-conditioning duct 32 and is blown toward the evaporator 30, and the blown air is cooled by the evaporator 30 which is cooled by the circulating refrigerant, thereby allowing dehumidification.

The air-conditioning duct 32 is provided with a heat-regenerative radiator (hereinafter referred to as "radiator 36") and a heater core 38, which are disposed adjacent to the evaporator 30. Air passing through the evaporator 30 further passes through the radiator 36 and the heater core 38 and is blown out from a blowout hole (not shown) into the vehicle interior.

A pair of hot-water pipes 40A and 40B are connected to the heater core 38 between the engine 14 and the heater core 38.

An electrically operated pump 42 is provided at an intermediate portion of one hot-water pipe 40A. Driving the electrically operated pump 42 allows cooling water for the engine 14 to be supplied to the heater core 38. The heater core 38 heats air passing through the heater core 38 with the cooling water serving as a refrigerant (the cooling water will be hereinafter referred to as "water refrigerant").

The other hot-water pipe 40B connected to the heater core 38 is branched off by a pair of branch pipes 44A and 44B. These branch pipes 44A, 44B are respectively provided with passage switching valves 46 and 48 in a pair. A heat storage tank 50 is connected to and between these passage switching valves 46 and 48. With the heat storage tank 50 communicating with the hot-water pipe 40B via the branch pipes 44A and 44B due to the operation of the passage switching valves 46 and 48, a water refrigerant circulated while being heated by the engine 14 is supplied to the heat storage tank 50.

The heat storage tank 50 is filled with a heat accumulating material surrounded by a heat insulating material. With the water refrigerant circulated between the heat storage tank 50 and the engine 14 passing through the heat storage tank 50, the heat accumulating material is heated by the water refrigerant. The heat storage tank 50 is maintained with the temperature of the heat accumulating material being kept by the heat insulating material. Further, when, while the engine 14 is

stopped, the electrically operated pump 42 is operated to allow the water refrigerant to be supplied to the heat core 38 to pass through the heat storage tank 50, the water refrigerant is heated due to heat exchange effected between the water refrigerant and the heat accumulating material. As a result, a water heating cycle is formed in which, even when the engine 14 is in a stopped state, air passing through the heater core 38 is heated to allow the vehicle interior to be heated.

On the other hand, a water-refrigerant heat exchanger 52 is mounted between the evaporator 30 and the compressor 20, which form the refrigerating cycle. The water-refrigerant heat exchanger 52 is cooled in such a manner that a refrigerant passing through the evaporator 30 is supplied to the water-refrigerant heat exchanger 52 and is further decompressed.

A pair of cold-water pipes 54A and 54B are connected to the radiator 36. One cold-water pipe 54B is connected to the water-refrigerant heat exchanger 52. The other cold-water pipe 54B is connected to the passage switching valve 48 and an electrically operated pump 56 is mounted at an intermediate portion of the other cold-water pipe 54B. Further, the water-refrigerant heat exchanger 52 is connected to the passage switching valve 46 by a cold-water pipe 54C. When the passage is switched to the heat storage tank 50 by the passage switching valves 46 and 48, a circulating passage for circulating the water

refrigerant between the heat storage tank 50, the water-refrigerant heat exchanger 52, and the radiator 36 is formed.

As a result, when the electrically operated pump 56 is operated to allow circulation of the water refrigerant, and the water refrigerant passes through the water-refrigerant heat exchanger 52, the cooled water refrigerant is supplied to the heat storage tank 50. The heat storage tank 50 allows the heat accumulating material to be cooled when the water refrigerant passes through the heat storage tank 50. Further, when the water refrigerant passing through the heat storage tank 50 is supplied to the radiator 36 by the operation of the electrically operated pump 56, the water refrigerant is cooled by the heat accumulating material within the heat storage tank 50. As a result, a water cooling cycle is formed in such a manner that the water refrigerant cooled in the heat storage tank 50 is supplied to the radiator 36 and air within the air-conditioning duct 32, passing through the radiator 36, is cooled.

The air conditioner 10 includes an air-conditioner ECU 60 which controls air conditioning. The air-conditioner ECU 60 has a general structure in which, by controlling each operation of the compressor 20, the blower fans 34, and the like in accordance with an operating state of an unillustrated operation panel (setting of an operating condition) while detecting the outside air temperature, the indoor air temperature, and the like, air for a cooling/heating operation or a dehumidifying operation is blown

out into the vehicle interior and the vehicle interior is thereby maintained in a desired air-conditioned state. Detailed illustration and description of the structure of the air-conditioner ECU 60 will be omitted.

The air conditioner 10 also includes a water-refrigerant control circuit 62. The water-refrigerant control circuit 62 is connected to the air-conditioner ECU 60 and also to an engine ECU (not shown) for controlling the engine 14. Further, the passage switching valves 46 and 48 and the electrically operated pumps 42 and 56 are each connected to the water-refrigerant control circuit 62.

Signals corresponding to an operating state of the air conditioner 10 and environmental conditions such as the outside air temperature, the indoor air temperature, and the like are inputted from the air-conditioner ECU 60 to the water-refrigerant control circuit 62. Further, a signal which indicates an operating state of the engine 14 is inputted from the engine ECU. The water-refrigerant control circuit 62 controls the passage switching valves 46 and 48 and the electrically operated pumps 42 and 56 based on the various signals.

Next, the operation of the first embodiment will be described with reference to the flow charts shown in Figs. 3 and 4. These flow charts each show an example of the operation of the water-refrigerant control circuit 62.

The flow chart shown in Fig. 3 shows an example of heat storage processing for the heat storage tank 50. In the first step 100, it is ascertained whether the engine 14 has been started (switched on), i.e., whether the hybrid car 12 is traveling using the engine 14. When it is determined that the engine 14 has been started, the process proceeds to step 102. In step 102, it is ascertained whether the air conditioner 10 is switched on.

When the air conditioner 10 is switched on (when the decision of step 102 is affirmative), the process proceeds to step 104, in which it is ascertained whether the air conditioner 10 is operating in a cooling mode or a heating mode. Further, when the air conditioner 10 is not switched on (when the decision of step 102 is negative), the process proceeds to step 106, in which environmental conditions such as the outside air temperature are measured. In step 108, it is determined from the measured environmental conditions such as the outside air temperature whether the possibility is of the air conditioner 10 being operated in a cooling mode or in a heating mode. For example, in the summer period in which the outside air temperature or the indoor temperature is high, there is a high possibility of the air conditioner 10 being operated in a cooling mode. In the winter period in which the outside air temperature or the indoor temperature is low, there is a high possibility of the air conditioner 10 being operated in a heating mode. Consequently, it can be determined whether the possibility is of the air

conditioner 10 being operated in a cooling mode or in a heating mode from a determination about whether the outside air temperature or the indoor temperature exceeds a previously set value.

As described above, when the air conditioner 10 is operated in the cooling mode (when the decision of step 104 is affirmative) or when there is a possibility of the air conditioner 10 being operated in the cooling mode (when the decision of step 108 is affirmative), the process proceeds to step 110, in which, by operating the passage switching valves 46 and 48, the heat storage tank 50 is connected to the cold-water pipes 54B and 54C and the electrically operated pump 56 is operated. As a result, circulation of the water refrigerant between the water-refrigerant heat exchanger 52 and the heat storage tank 50 is started.

When the engine 14 has been started, the driving force of the engine 14 is transmitted via the V belt 26 to the compressor 20 and the driving shaft 20A of the compressor 20 is thereby rotated. As a result, the refrigerant compressed and discharged from the compressor 20 is supplied to the water-refrigerant heat exchanger 36 and the water refrigerant circulated in the water-refrigerant heat exchanger 36 is cooled. The water refrigerant cooled by the water-refrigerant heat exchanger 36 is transferred to the heat storage tank 50 to cool the heat accumulating material within the heat storage tank 50. As a result, heat for a cooling operation is stored in the heat storage tank 50.

When the air conditioner 10 is operated in the heating mode (when the decision of step 104 is negative) or when there is a possibility of the air conditioner 10 being operated in the heating mode (when the decision of step 108 is negative), the process proceeds to step 112, in which by operating the passage switching valves 46 and 48, the heat storage tank 50 is connected to the branch pipes 44A and 44B branched off from the hot-water pipe 40B and the electrically operated pump 42 is operated. As a result, circulation of the water refrigerant heated by the engine 14 is started and the heated water refrigerant is supplied from the engine 14 to the heat storage tank 50. When the water refrigerant placed in a high-temperature state by cooling the engine 14 passes through the heat storage tank 50 from the engine, the heat accumulating material in the heat storage tank 50 is heated to allow storage of heat for the heating operation.

The heat storage operation in the heat storage tank 50 is continuously carried out until it is determined that the engine 14 has been stopped in step 114 or in step 116. When the engine 14 is stopped, in step 118, the passage switching valves 46 and 48 may be closed to prevent outflow of the water refrigerant from the heat storage tank 50, and the like. Further, the time of completion of the heat storage operation in the heat storage tank 50 may be set, for example, for when the temperature of the heat accumulating material in the heat storage tank 50, which is detected by a temperature sensor or the like, reaches a

predetermined temperature, or when the change in the temperature is reduced to nothing.

Fig. 4 shows an example in which the heat storage tank 50 is used as a heat source for heating or air-cooling. In the first step 120 in this flow chart, it is ascertained whether the air conditioner 10 is switched on. Further, in the subsequent step 122, it is ascertained whether the engine 14 is started (switched on).

When the engine 14 is started, a normal air-conditioning operation is allowed in which the heat of cooling water for the engine 14 and the compressor 20 to be driven by the engine 14 are used. Accordingly, when the decision of step 122 is affirmative, the process proceeds to step 124, in which the normal operation of the air conditioner 10 is started.

On the other hand, when the air conditioner 10 is switched on (when the decision of step 120 is affirmative) and when the engine 14 is in a stopped state (when the decision of step 122 is negative), the process proceeds to step 126, in which it is ascertained whether the air conditioner 10 can be operated with the heat storage tank 50 serving as the heat source. When the operation mode of the air conditioner 10 and heat stored in the heat storage tank 50 coincide with each other, namely, when the air conditioner 10 is set in a cooling mode in a state in which heat for air-cooling is stored in the heat storage tank 50 and when the air conditioner 10 is set in a heating mode in a state in

which heat for heating is stored in the heat storage tank 50, the decision of step 126 is made affirmative, and the process proceeds to step 128.

When the air conditioner 10 is set in the heating mode and the heat source for heating is provided in the heat storage tank 50, the decision of step 128 is made negative and the process proceeds to step 130. As a result, the passage switching valves 46 and 48 are operated to allow connection between the heat storage tank 50 and each of the branch pipes 44A and 44B, and further, the electrically operated pump 42 is actuated to start circulation of the water refrigerant between the heat storage tank 50 and the heater core 38. The circulated water refrigerant is heated by the heat accumulating material as it passes through the heat storage tank 50 and is transferred to the heater core 38. The water refrigerant transferred to the heater core 38 heats air which passes through the heater core 38 within the air-conditioning duct 32. As a result, heated air is blown out from the air-conditioning duct 32 to allow the vehicle interior to be heated.

On the other hand, when the air conditioner 10 is set in the cooling mode, the decision of step 128 is affirmative and the process proceeds to step 132. As a result, the passage switching valves 46 and 48 allow connection between the heat storage tank 50 and each of the cold-water pipes 54B and 54C, and further, the electrically operated pump 56 is actuated to start circulation

of the water refrigerant between the heat storage tank 50 and the radiator 36. The water refrigerant transferred from the heat storage tank 50 to the radiator 36 due to the operation of the electrically operated pump 56 is cooled by the heat accumulating material in the heat storage tank 50 as it passes through the heat storage tank 50 and is further transferred to the radiator 36. The water refrigerant supplied to the radiator 36 allows the cooling of air passing through the radiator 36. As a result, air cooled by the radiator 36 is blown out into the vehicle interior and air-cooling for the vehicle interior is achieved.

The cooling or heating operation using the heat storage tank 50 is continuously carried out based on the confirmation that the air conditioner 10 was switched on in step 134 or in step 136. When the air conditioner 10 is switched off, the process proceeds to step 138, in which the process ends by the electrically operated pump 42 or the electrically operated pump 56 being stopped. When the flow chart is being executed, the water-refrigerant control circuit 62 monitors to determine whether the engine 14 has been started. When the engine 14 is started, heating and air-cooling with the heat storage tank 50 used as the heat source is stopped and the heat storage operation in the heat storage tank 50 is started again.

As described above, the air conditioner 10 is constructed in such a manner that, when the engine 14 is started, heat for air conditioning is stored in the heat storage tank 50, and when the

air conditioner 10 is operated in the state in which the engine 14 has been stopped, cooling or heating for the vehicle interior is effected by the heat stored in the heat storage tank 50. For this reason, even when the engine 14 is stopped, the vehicle interior is able to be air-conditioned. Further, it is not necessary to provide a power source used only for operating the compressor 20 which effects air conditioning for the vehicle interior when the engine 14 is in a stopped state, and there is no possibility of the electrically operated motor 16 being actuated to operate the compressor 20. For this reason, no extra large load is applied to the battery.

Meanwhile, in the first embodiment, heat for cooling or heating is stored in the heat storage tank 50 by switching the circulating passage of the water refrigerant for the heat storage tank 50 by the passage switching valves 46 and 48. However, separate heat storage tanks may be respectively provided for the heating and cooling operations. As a result, either of the cooling and heating operations can be selected irrespective of environmental conditions and the like, so as to allow air conditioning (cooling and heating) according to a vehicle occupant's preference.

Further, the heat storage tank 50 is not limited to a structure which stores heat in the heat accumulating material. For example, a structure in which a heated or cooled water refrigerant is stored and the stored water refrigerant is released

as occasion demands may be used. Further, there can also be used other various structures which each allow efficient heat storage and heat dissipation.

In the first embodiment, there was described a structure in which the water-refrigerant control circuit 62 is provided separately from the air-conditioner ECU 60, but the air-conditioner 60 may be provided to serve as the water-refrigerant control circuit 62.

(Second Embodiment)

Next, a second embodiment of the present invention will be described. It should be noted that the basic structure of the second embodiment is the same as that of the first embodiment and that the same members as those of the first embodiment will be denoted by the same reference numerals, and a description thereof will be omitted.

As shown in Fig. 5, an air conditioner 64 applied to the second embodiment is provided with the heater core 38 in the air-conditioning duct 32, but is not provided with the radiator 36. A pair of hot-water pipes 40A and 40B are connected to the heater core 38 and between the engine 14 and the heater core 38. The operation of the electrically operated pump 42 provided in the hot-water pipe 40A allows circulation of a water refrigerant between the engine 14 and the heater core 38.

Further, a heat storage tank 66 is provided in the hot-water pipe 40A between the electrically operated pump 42 and

the engine 14. When the engine 14 is driven, heat for heating is stored in the heat storage tank 66.

On the other hand, a V belt 26 is entrained between a pulley 22 mounted to the driving shaft 20A of the compressor 20 and a pulley 24 mounted to the output shaft 18. When any one of the engine 14 and the electric motor 16 is driven to rotate the output shaft 18, the compressor 20 is actuated.

A clutch 68 serving as driving force switching means is provided in the output shaft 18 between the pulley 24 and the engine 14. The clutch 68 is operated by a clutch operating means 70 so that the driving shaft 14A of the engine 14 and the output shaft 18 are separated from each other in a relatively rotatable manner.

The clutch operating means 70 is connected to the air-conditioner ECU 60. When the air conditioner 64 is operated while the electric motor 16 is being driven, the air-conditioner ECU 60 outputs an operation signal of the clutch 68 to the clutch operating means 70. When the operation signal is inputted from the air-conditioner ECU 60 to the clutch operating means 70, the clutch operating means 70 operates the clutch 68 so as to separate the output shaft 18 and the driving shaft 14A of the engine from each other.

As a result, when the operation switch of the air conditioner 64 is operated while the electric motor 16 is being driven, the electric motor 16 is separated from the engine 14 to

prevent the load for rotating the driving shaft 14A of the engine 14 being applied to the electric motor 16.

In the air conditioner 64 structured as described above, when the heating operation is indicated (the heating mode is set by an unillustrated operation panel) with the engine 14 being driven, a water refrigerant is circulated between the engine 14 and the heater core 38. As a result, the water refrigerant which has been heated to a high temperature by cooling the engine 14 passes through the heater core 38 and heats air to be blown out into the vehicle interior, thereby allowing heating for the vehicle interior.

Further, when the engine 14 is stopped, heat for heating stored in the heat storage tank 66 when the electrically operated pump 42 is actuated to drive the engine 14 is supplied to the heater core 38 using the water refrigerant. As a result, even when the engine 14 has been stopped, the air conditioner 64 enables the vehicle interior to be heated without starting the engine 14.

In the air conditioner 64, when air-cooling or dehumidification of the vehicle interior is carried out, the compressor 20 is actuated. When the engine 14 is driven, the driving force of the engine 14 is transmitted from the driving shaft 14A to the output shaft 18 via the clutch 68. The rotation of the output shaft 18 is transmitted from the pulley 24 to the

pulley 22 mounted to the driving shaft 20A of the compressor 20 by the V belt 26 and the compressor 20 is thereby driven.

On the other hand, in the air conditioner 64, it is determined that the engine 14 has been stopped by a signal from an engine ECU (not shown), the operation signal of the clutch 68 is outputted to the clutch operating means 70. When the operation signal of the clutch 68 is inputted to the clutch operating means 70, the clutch operating means 70 operates the clutch 68 so as to separate the output shaft 18 and the driving shaft 14A of the engine 14 from each other.

As a result, when the electric motor 16 is driven, the output shaft 18 to which the driving force of the electric motor 16 is outputted and the driving shaft 14A of the engine 14 are separated from each other. For this reason, the compressor 20 can be driven with no large load for rotating the output shaft 14A of the engine 14 being applied to the electric motor 16.

As described above, although the compressor 20 is driven to rotate by the electric motor 16 by separating the output shaft 18 to which the driving force of the electric motor 16 is outputted and the driving shaft 14A of the engine 14 from each other, there is no possibility of application of a large load which impedes driving of the electric motor 16, and the air conditioner 64 can be operated by the driving force of the electric motor 16.

Accordingly, in the second embodiment as well, in the same way as in the first embodiment, when the air conditioner 64

is operated, it is not necessary that the engine 14 be started to drive the compressor 20 and it is possible to prevent deterioration of fuel consumption, which is caused by starting the engine 14 to operate the air conditioner 64. Further, it is also not necessary to provide a motor used only for driving the compressor 20 without starting the engine 14.

(Third Embodiment)

Next, a third embodiment of the present invention will be described. It should be noted that the basic structure of the third embodiment is the same as that of the second embodiment, and that the same members as those of the second embodiment will be denoted by the same reference numerals, and a description thereof will be omitted. Further, in the third embodiment, driving of the compressor 20 will be mainly described, and an illustration and description of a heating mechanism will be omitted.

Fig. 6 shows a schematic structure of an air conditioner 200 applied to the third embodiment. A hybrid car equipped with the air conditioner 200 includes an engine 202 and an electric motor 204. Only the layout of the engine 202 and the electric motor 204 is different from the layout shown in the first and second embodiments, but each basic operation of the engine 202 and the electric motor 204 is the same as that of the engine 14 and the electric motor 16, which are applied to each of the first and second embodiments.

A double pulley clutch 206 serving as driving force switching means is mounted to the driving shaft 20A of the compressor 20 in the air conditioner 200. As shown in Fig. 7, the driving shaft 20A of the compressor 20 is disposed rotatably so as to project from a cylindrical housing 208, which projects from a compressor main body, with a bearing 210 interposed between the driving shaft 20A and the housing 208.

A driving wheel 212 is disposed on an outer peripheral surface of the housing 208. The driving wheel 212 is rotatably supported by the housing 208 via a bearing 214 mounted on the outer peripheral surface of the housing 208. A pulley 216 is formed on an outer peripheral surface of the driving wheel 212 and the driving wheel 212 is rotated by driving force transmitted thereto via the pulley 216.

On the other hand, a pulley 218 is mounted at an end portion of the driving shaft 20A of the compressor 20 projecting from the housing 208 and the driving shaft 20A thereby rotates integrally with the pulley 218.

Further, a passive wheel 220 is disposed in the driving shaft 20A of the compressor 20 between the pulley 218 and the driving wheel 212. The passive wheel 220 rotates integrally with the driving shaft 20A. A passive plate 222 is mounted on the driving wheel 212 side of the surface of the driving wheel 220. The passive plate 222 rotates integrally with the passive wheel

220 and is also mounted in such a manner as to be movable along an axial direction of the driving shaft 20A by a small amount.

A space is formed within the driving wheel 212 and an electromagnetic coil 224 is disposed in the space. Further, the surface of the driving wheel 212 facing the passive plate 222 is formed as a driving plate 226. Namely, the electromagnetic coil 224 and the passive plate 222 are disposed with the driving plate 226 interposed therebetween. The electromagnetic coil 224 is mounted to the compressor 20 and is allowed to rotate relatively with the driving wheel 212.

The passive plate 222 provided in the passive wheel 220 is slightly separated from the driving plate 226 of the driving wheel 212. As a result, the driving wheel 212 and the passive wheel 220 are allowed to rotate relatively. Further, the passive plate 222 adheres closely to the driving plate 226 due to being attracted by magnetic force caused by magnetization of the electromagnetic coil 224. As a result, the passive plate 222 and the driving plate 226 rotate integrally and rotating force transmitted to the pulley 216 is transmitted to the driving shaft 20A of the compressor 20 so as to drive and rotate the driving shaft 20A.

As shown in Fig. 6, a V belt 232 serving as first driving force transmitting means is entrained between the pulley 216 mounted to the double pulley clutch 206 and a pulley 230 mounted to a crank shaft 228 of the engine 202. Accordingly, the

driving force of the engine 202 is transmitted from the crank shaft 228, which is driven to rotate by driving of the engine 202, to the pulley 218.

Further, a V belt 236 serving as second driving force transmitting means is entrained between the pulley 218 mounted to the double pulley clutch 206 and the pulley 234 mounted to the driving shaft 204A of the electric motor 204. As a result, the driving force of the electric motor 204 is transmitted to the driving shaft 20A of the compressor 20 via the V belt 236 and the pulley 218.

The air conditioner 200 includes an air-conditioner ECU 238 for controlling the operation of the air conditioner 200. The air-conditioner ECU 238 is connected to an engine ECU 240 for controlling each operation of the engine 202 and the electric motor 204. Further, the double pulley clutch 206 is controlled by the air-conditioner ECU 238.

Namely, when the electromagnetic coil 224 of the double pulley clutch 206 is magnetized by the air-conditioner ECU 238, the driving force of the engine 202 to be transmitted to the pulley 216 is transmitted to the driving shaft 20A of the compressor 20 via the driving plate 226 and the passive plate 222. As a result, the compressor 20 is driven by the driving force of the engine 202. Further, with the electromagnetic coil 224 being brought into a non-magnetized (off) state, the passive plate 224 and the driving plate 226 is allowed to rotate relatively. At this time, even

when the electric motor 204 is driven, no driving force of the electric motor 204 is transmitted to the crank shaft 228 of the engine 202 so as to prevent application of a load from the engine 202 to the electric motor 204.

Here, with reference to the flow chart shown in Fig. 8, a driving source switching operation when the air conditioner 200 is operated will be described.

In the flow chart, first, in step 140, it is ascertained whether the air conditioner 200 has been operated (switched on). When the air conditioner 200 has not been operated (has not been switched on), the decision of step 140 is negative and the process proceeds to step 142, in which the electromagnetic coil 224 is switched off.

In the double pulley clutch 206, when the electromagnetic coil 224 is switched off (is not magnetized), the driving plate 226 and the passive plate 222 are allowed to rotate relatively and no driving force of the engine 202 is transmitted to the compressor 20. Further, when the electric motor 204 is driven, no driving force of the electric motor 204 is transmitted to the engine 202.

Here, when the air conditioner 200 is switched on, the decision of step 140 is affirmative and the process proceeds to step 144. In step 144, it is ascertained whether the engine 202 is driven. When the engine 202 is driven (when the decision of step 144 is affirmative), the process proceeds to step 146, in which the

electromagnetic coil 24 of the double pulley clutch 206 is switched on (magnetized).

As a result, the driving force of the engine 202 is transmitted via the double pulley clutch 206 to the compressor 20, and with the compressor 20 being driven by the driving force of the engine 202, the air conditioner 200 is operated. At this time, it is not necessary that the electric motor 204 be driven, and therefore, the electric motor 204 is set in a stopped state.

On the other hand, when the engine 202 has been stopped (when the decision of step 144 is negative), the process proceeds to step 148, in which the double pulley clutch 206 is switched off (is not magnetized) and the electric motor 204 is switched on so as to drive the compressor 20. As a result, the driving force of the electric motor 204 is transmitted to the compressor 20 to drive the compressor 20. At this time, the electromagnetic coil 224 of the double pulley clutch 206 is set in a non-magnetized state. For this reason, no driving force of the electric motor 204 is transmitted to the engine 202 in a stopped state and no large load is thereby applied to the electric motor 204.

In the above-described second embodiment, the clutch 68 is provided, as the driving force switching means, in the output shaft 18 (see Fig. 5). Accordingly, the clutch 68 needs to have a capacity which allows transmission of the maximum

driving force generated by the engine 14 and the electric motor 16, which results in a large size and a high cost.

On the other hand, in the double pulley clutch 206 used as the driving force switching means in the present embodiment, the maximum load is applied when the compressor 20 is operated at the maximum capacity, and the driving force required at this time can be set at an extremely small value as compared with the maximum driving force of the engine 14 (for example, about one tenth of the maximum driving force). Accordingly, a small capacity of the double pulley clutch 206 for transmission of driving force suffices (for example, about one tenth of the maximum driving force), and therefore, the driving force transmitting means can be formed to be of a small size and also at a low cost.

(~~Fourth~~ Second Embodiment)

Next, a ~~fourth~~ second embodiment of the present invention will be described. ~~It should be noted that the basic structure of the fourth embodiment is the same as that of the above-described second embodiment, and that the same members as those of the second embodiment will be denoted by the same reference numerals, and a description thereof will be omitted.~~

As shown in Fig. ~~9~~ 5, an air conditioner 72 applied to the fourth embodiment allows heating by using heat of the engine 14 when the engine 14 is driven. Further, when the engine 14 is stopped, heating can be effected by using heat of the engine 14

stored in the heat storage tank 66 when the electrically operated pump 42 is actuated to drive the engine 14.

Further, the compressor 20 of the air conditioner 72 is rotated due to the driving force from the output shaft 18 to which the engine 14 and the electric motor 16 are each connected.

An engine ECU 74 which controls the operation of the engine 14 is connected to the air-conditioner ECU 60. The engine ECU 74 is generally structured to operate based on a conventional publicly-known engine control method to control the engine 14. In the present embodiment, only the structure relating to the present invention will be described herein.

A throttle valve 76 and a fuel injector 78 are each connected to the engine ECU 74. The throttle valve 76 is operated in accordance with an operation of an accelerator pedal (not shown) and the fuel injector 78 is actuated in accordance with the opening of the throttle valve 76 and the operating state of the engine 14. As a result, the proper amounts of both air and fuel are supplied to each cylinder of the engine 14.

The engine 14 is provided with valve opening means 84 which opens an intake valve 80 and an exhaust valve 82. The valve opening means 84 is connected to the engine ECU 74, and based on an operation signal from the engine ECU 74, the valve opening means 84 opens the intake valve 80 and the exhaust valve 82.

Generally, when the intake valve 80 and the exhaust valve 82 are opened and the throttle valve 76 is brought into a full-open state, the intake/exhaust resistance when the piston is moving reciprocally in a cylinder is reduced in the engine 14. As a result, the friction for rotating the driving shaft 14A when the engine 14 is in a stopped state is reduced and the driving shaft 14A of the engine 14 can be rotated by a small driving force.

In the air conditioner 72 structured as described above, when the engine 14 is stopped at the time of the cooling or dehumidifying operation, and the cooling or dehumidifying operation is indicated while the electric motor 16 is being driven (cooling or dehumidification is set by an unillustrated operation panel), a valve opening signal is outputted to the engine ECU 74. When the valve opening signal is inputted to the engine ECU 74, the throttle valve 76 is brought into a full-open state and the intake valve 80 and the exhaust valve 82 are opened. At this time, the injection of fuel from the fuel injector 78 is, of course, prohibited. Further, the opening of the throttle valve 76, the intake valve 80, and the exhaust valve 82 may be carried out not only at the time of the operation of the air conditioner 72, but also when the engine 14 is stopped or the electric motor 16 is being driven.

On the other hand, the air conditioner 72 is operated in such a manner that the compressor 20 is rotated by the driving force of the electric motor 16. At this time, no large friction for

rotating the driving shaft 14A of the engine 14 is applied to the electric motor 16, and therefore, the compressor 20 can be driven.

As described above, in the ~~fourth~~ Second embodiment as well, it is not necessary that the engine 14 be actuated when the air conditioner 72 is operated, thereby preventing deterioration of fuel consumption caused by starting the engine 14. Further, it is also not necessary to provide driving means used only for driving the compressor 20 in a state in which the engine 14 is stopped, and therefore, there is no need of an increase in parts for operating the air conditioner 72.

~~Further, although the clutch 68 is provided in the second embodiment, no provision of any special parts such as the clutch 68 is required in the present embodiment.~~

(~~Fifth~~ Third Embodiment)

The method for driving the compressor 20 without starting the engine 14 while the engine 14 is stopped is not limited to the above-described ~~first, second, third, and fourth~~ First and Second embodiments. A ~~fifth~~ Third embodiment will be hereinafter described with reference to Fig. ~~10~~ 6.

Even in the case of a hybrid car, provision of a plurality of auxiliary machines such as a power steering pump is required, and even when the engine 14 has been stopped, it is necessary to drive these auxiliary machines. As shown in Fig. ~~10~~ 6, the compressor 20 of the air conditioner 86 is, together with an

alternator 88 and a power steering pump 90, driven by the driving force of an auxiliary machine motor 92.

Namely, a V belt 94 is entrained between a pulley 92A mounted to a driving shaft of the auxiliary machine motor 92, a pulley 88A mounted to a driving shaft of the alternator 88, a pulley 90A mounted to a driving shaft of the power steering pump, and a pulley 22 of the compressor 20, and the compressor 20 is rotated by the driving force of the auxiliary machine motor 92.

In the above-described structure as well, even when the engine 14 has been stopped, the compressor 20 can be driven without starting the engine 14. Further, a plurality of auxiliary machines are driven concurrently without providing driving means used only for driving the compressor 20, and therefore, it is not necessary to provide separate driving means for driving not only the compressor 20 but also the auxiliary machines.

Further, the alternator 88 is driven by the auxiliary machine motor 92 so as to allow the generation of a voltage different from that of the electric power for driving the electric motor 16. Usually, the working voltage of the electric motor 16 is set at a high value (for example, about 288V) because the electric motor 16 requires a large driving force. For this reason, it is necessary that the electric motor 16 be transformed to a suitable voltage (for example, 12V) using a DC/DC converter or the like so as to operate devices such as the air-conditioner ECU 60 and the

like. On the other hand, electric power of this voltage (12V) can be directly generated by providing the alternator 88, and therefore, an effect that an expensive DC/DC converter becomes unnecessary is obtained, and further, reduction in cost of the parts used for a hybrid car can be achieved.

(~~Sixth~~ Fourth Embodiment)

Next, an example of an air conditioner for a vehicle using the auxiliary machine motor 92 will be described, as a ~~sixth~~ Fourth embodiment, with reference to Figs. ~~11A~~ 7A, ~~11B~~ 7B, and ~~12~~ 8. It should be noted that the basic structure of the ~~sixth~~ fourth embodiment is the same as that ~~of each~~ of the above-described third ~~and fifth~~ embodiment~~s~~, and that the same members as those ~~of each~~ of the third ~~and fifth~~ embodiment~~s~~ will be denoted by the same reference numerals, and a description thereof will be omitted.

13

As shown in Figs. ~~11A~~ 7A and ~~11B~~ 7B, the pulley 22 is mounted to the driving shaft 20A of the compressor 20 in an air conditioner 250. The auxiliary machine motor 92 is provided in the vicinity of an engine 202. A V belt 252 serving as ~~third~~ Second driving force transmitting means is entrained between the pulley 92A of the auxiliary machine motor 92, the pulley 22 of the compressor 20, and a pulley 230 mounted to a crank shaft 228 of the engine 202.

Further, the air conditioner 250 includes a water pump 254 mounted to the engine 202 in place of the electrically operated pump 42. When the water pump 254 is driven, cooling

water for the engine 202 is supplied to the heater core 38 so as to allow the vehicle interior to be heated.

The V belt 252 is also entrained onto a pulley 256 mounted to a driving shaft 254A of the water pump 254, and the water pump 254 can be driven by the driving force of the engine 202 or the driving force of the auxiliary machine motor 92. Meanwhile, other auxiliary machines such as the power steering pump 90 and the like (not shown in Fig. ~~11A~~ 7A) are also connected to the auxiliary machine motor 92, and when the pulley 92A is rotated by the driving force of the engine 202, the rotating force is also transmitted to these other auxiliary machines.

On the other hand, as shown in Fig. ~~11A~~ 7A, a crank clutch 258 serving as driving force interruption means is provided in the crank shaft 228 and a compressor clutch 260 is provided in the driving shaft 20A of the compressor 20. The crank clutch 258 separates the crank shaft 228 of the engine 202 and the pulley 230 from each other enabling the crank shaft 228 and the pulley 230 to be relatively rotatable. Further, the compressor clutch 260 separates the driving shaft 20A of the compressor 20 and the pulley 22 from each other enabling the driving shaft 20A and the pulley 22 to be relatively rotatable.

The crank clutch 258 and the compressor clutch 260 are each connected to an air-conditioner ECU 238, and the auxiliary machine motor 92 can also be driven by being controlled by the air-conditioner ECU 238.

The air-conditioner ECU 238 is provided to control the auxiliary machine motor 92, the crank clutch 258, and the compressor clutch 260 in accordance with the operating state of the air conditioner 250 and the operating state of the engine 202.

Next, with reference to the flow chart shown in Fig. ~~12~~ 8, the switching of a driving source such as the compressor 20 when the air conditioner 250 is operated will be described.

In the flow chart, first, in step 150, it is ascertained whether the engine 202 is started (switched on). When the engine 202 is switched on (when the decision of step 150 is affirmative), the process proceeds to step 152, in which the crank clutch 258 is switched on (is connected) and the auxiliary machine motor 92 is stopped (is switched off). As a result, the V belt 252 is driven to rotate by the driving force of the engine 202 and other auxiliary machines connected to the water pump 254 or the auxiliary machine motor 92 are driven by the driving force of the engine 202.

In the subsequent step 154, it is ascertained whether the air conditioner 250 has been switched on, namely, whether the compressor 20 need to be driven. Here, when the air conditioner 250 has been switched on and the compressor 20 needs to be driven (when the decision of step 154 is affirmative), the process proceeds to step 156, in which the compressor clutch 260 is switched on. As a result, the driving force of the engine 202 is

transmitted to the compressor 20 and the compressor 20 is thereby driven by the driving force of the engine 202.

Further, when the air conditioner 250 has not been switched on, namely, when the compressor 20 does not need to be driven (when the decision of step 154 is negative), the process proceeds to step 158, in which the compressor clutch 260 is switched off. As a result, the compressor 20 is not driven and the water pump 254 is driven, and therefore, heating is made possible. Further, other auxiliary machines connected to the auxiliary machine motor 92 are also driven by the driving force of the engine 202.

On the other hand, when the engine 202 has been stopped (when the decision of step 150 is negative), the process proceeds to step 160, in which the crank clutch 258 is switched off and the crank shaft 228 and the pulley 230 are separated from each other.

In the subsequent step 162, it is ascertained whether the air conditioner 250 has been switched on. When the air conditioner 250 has been switched on (when the decision of step 162 is affirmative), the process proceeds to step 164, in which the compressor clutch 260 is switched on and the auxiliary machine motor 92 is driven (switched on). As a result, the driving force of the auxiliary machine motor 92 is transmitted to the compressor 20 and also to the water pump 254 and the air conditioner 250 is operated by the driving force of the auxiliary machine motor 92.

Further, when the air conditioner 250 has not been switched on (when the decision of step 162 is negative), the process proceeds to step 166, in which the compressor clutch 260 is switched off. In the subsequent step 168, it is ascertained whether the heating operation is being effected, i.e., whether the heating operation is to be effected.

When the heating operation is effected (when the decision of step 168 is affirmative), the process proceeds to step 170, in which the auxiliary machine motor 92 is driven. As a result, the driving force of the auxiliary machine motor 92 is transmitted via the V belt 252 to the water pump 254 and cooling water of the engine 202 is supplied to the heater core 38. At this time, the crank clutch 258 and the compressor clutch 260 are each switched off, and therefore, there is no possibility of an unnecessary load being applied to the auxiliary machine motor 92.

Meanwhile, when the heating for the vehicle interior is not effected (when the decision of step 168 is negative), the process proceeds to step 172, in which the auxiliary machine motor 92 is left stopped. At this time, if it is necessary to operate other auxiliary machines connected to the auxiliary machine motor 92, the auxiliary machine motor 92 may be operated.

As described above, in the air conditioner 250 applied to the fifth embodiment as well, it is not necessary to use a motor used only for driving the compressor 20 and also not necessary to

start the engine 202, thereby preventing deterioration of fuel consumption which is caused due to the engine 202 driving the compressor 20. Further, it is not necessary to provide the electrically operated pump 42 which is used to supply cooling water to the heater core 38 for the heating operation, and therefore, reduction in the number of parts and reduction in costs can be achieved.

Further, even if a hybrid car is temporarily stopped by reason of waiting for a traffic light or loading and unloading, and further, the engine 202 is stopped, air conditioning for the vehicle interior by the auxiliary machine motor 92 becomes possible.

In recent years, it has become possible for the engine to be stopped when a vehicle stops temporarily (short-time stopping) from the standpoint of fuel problems or environmental issues. However, even in this case, it is not necessary to stop the air conditioning for the vehicle interior. The same is not limited to the hybrid car, and can also be applied to a general vehicle having no electric motor serving as a driving source for a running operation.

Meanwhile, the transmission of driving force to the compressor 20 and the switching of a driving source are not limited to the aforementioned. For example, as shown in Fig. 11C, with the double pulley clutch 206 applied to the third embodiment being used in the driving shaft 20A of the

compressor 20, a V belt 262 may be entrained between the pulley 216 and the pulley 92A of the auxiliary machine motor 92 and a V belt 264 may be entrained between the other pulley 218, a pulley 230, and a pulley 256.

As a result, when the air conditioner 250 is operated, it suffices that the double pulley clutch 206 be switched on at the time of operation (including a heating operation) of the air conditioner 250 using the auxiliary machine motor 92. Further, when the air conditioner 250 is not operated, so long as the double pulley clutch 206 is switched off, only the other auxiliary machines can be driven by the auxiliary machine motor 92 as occasion demands.

Further, in the sixth embodiment, the air-conditioner ECU 238 is used as the control means. However, the crank clutch 258, the compressor clutch 260, and the auxiliary machine motor may be each controlled by the engine ECU. Alternatively, a controller used only for these devices may be provided.

Meanwhile, in each embodiment of the present invention, the description given was that for a hybrid car, but the present invention can also be applied to vehicles of various structures, each traveling by the driving force of an engine without using an electric motor. In a vehicle which travels using an engine as a driving source, a so-called economy running system has been proposed in which the engine is stopped when the vehicle stops

so as to improve fuel consumption and also inhibit emission of exhaust gas. In the case of using the economy running system, when the engine is stopped, driving of the compressor is also stopped. At this time, when the present invention is applied, the vehicle interior can be maintained in a comfortable air-conditioned state without stopping air conditioning in the vehicle interior.

In this case, for example, in the second and third embodiments, an alternator/starter motor can be used in place of the electric motor. The alternator/starter motor operates as a starter motor at the time of starting the engine, and during the operation of the engine, it operates as an alternator which generates power by the driving force of the engine.

As a result, when the engine is operated to allow a running operation, air conditioning for the vehicle interior can be carried out by driving the compressor while effecting power generation/charging by the alternator/starter motor.

On the other hand, when driving of the engine is stopped by stopping the vehicle, the engine and the alternator/starter motor are separated from each other and the alternator/starter motor is driven as the electric motor. As a result, the driving force of the alternator/starter motor is transmitted to the compressor without being transmitted to the engine, thereby allowing air conditioning for the vehicle interior using the compressor.

As a result, even when the engine 14 is in a stopped state, air conditioning for the vehicle interior can be effected by driving the compressor 20.

INDUSTRIAL APPLICABILITY

The above-described present invention allows air-cooling and heating in which the power of an engine is efficiently utilized. Further, the present invention also allows the driving of a compressor by an electric motor without starting an engine and is useful as an air conditioner not only for a vehicle which travels by the driving force of the engine, but also for a hybrid car which travels by the driving force of the electric motor in addition to that of the engine.